SUBSTITUTE SPECIFICATION

ELECTRONIC COMPONENT DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]   The present invention relates to an electronic component device in which a rectangular plate-shaped electronic component element having a functional part thereon is mounted on a substrate with bumps. In further detail, the present invention relates to an electronic component device in which a rectangular plate-shaped electronic component element is mounted on a substrate so that a functional part of the electronic component element is hermetically sealed. The electronic component element has a coefficient of linear expansion in the x direction along a side of the rectangle and a coefficient of linear expansion in the y direction orthogonal to the x direction in the plane of the rectangle, wherein the coefficients of linear expansion being different from each other.

2. Description of the Related Art

[0002]   Hitherto, various electronic component devices in which an electronic component element (hereinafter also abbreviated to as an element), such as a SAW element or a high-frequency element, is installed on a substrate have been proposed.

[0003]   For example, Japanese Unexamined Patent Application

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Publication No. 4-293310 discloses a surface acoustic wave device in which a SAW element is mounted on a base plate with bumps. In more detail, hot-side lands are provided on a surface of the base plate and solder bumps are provided on the corresponding hot-side lands. In addition, a frame-shaped earth-side land is provided on the surface of the base plate so as to surround the hot-side lands. A solder sealing frame is provided on the frame-shaped earth-side land. On the other hand, interdigital transducers (IDT), hot-side patterns, and earth-side patterns are provided on a surface of a SAW element chip to form a functional part. The SAW element is fixed on the base plate with a predetermined space therebetween such that the surface having the IDTs of the SAW element faces the surface of the base plate. The space is hermetically sealed with the solder sealing frame.

[0004] However, in the surface acoustic wave device described in Japanese Unexamined Patent Application Publication No. 4-293310, the coefficient of linear expansion in the x direction along a side of the rectangular plate-shaped SAW element is different from the coefficient of linear expansion in the x direction of the base plate. In addition, the coefficient of linear expansion in the y direction, which lies in the plane of the rectangle of the SAW element and is orthogonal to the x direction, is different from the coefficient of linear expansion in the y direction of the base plate. Thus, in the SAW element and the base plate, the coefficients of linear expansion in the same direction are different from each other. Therefore, when a thermal shock is

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applied during a reliability test or during use, a large difference in expansion is generated between the SAW element and the base plate. Consequently, a strain or a fatigue breaking is generated in the sealed portion, resulting in a sealing failure. This causes a problem that the lifetime for thermal shock resistance required for general electronic component devices cannot be satisfied.

SUMMARY OF THE INVENTION

[0005]   In order to overcome the problems described above, preferred embodiments of the present invention provide an electronic component device satisfying the lifetime for thermal shock resistance required for general electronic component devices and having excellent reliability.

[0006]   The preferred embodiments provide an electronic component device including a rectangular plate-shaped element including a front face, a reverse face, a functional part provided on the front face, and a first frame-shaped electrode surrounding the functional part, wherein the coefficient of linear expansion in the x direction along a side of the rectangle is different from the coefficient of linear expansion in the y direction orthogonal to the x direction in the rectangular plane; a substrate including a front face, a reverse face, and a second frame-shaped electrode provided on the front face at a position corresponding to the first frame-shaped electrode; and a solder sealing frame provided on the surface of at least one of the first frame-shaped electrode and the second frame-shaped electrode. In the electronic

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component device, each of the first frame-shaped electrode, the second frame-shaped electrode, and the solder sealing frame includes a strip-shaped portion extending in the x direction and a strip-shaped portion extending in the y direction, the element and the substrate are bonded with the solder sealing frame, and the functional part provided on the front face of the element is hermetically sealed in a space formed between the element and the substrate. In the electronic component device, the difference in expansion in the x direction between the element and the substrate is represented by Q_x and the difference in expansion in the y direction between the element and the substrate is represented by Q_y. Then, in each of the first frame-shaped electrode, the second frame-shaped electrode, and the solder sealing frame, the width of the strip-shaped portion extending in the direction in which the larger difference in expansion is generated between the differences Q_x and Q_y in expansion is smaller than the width of the strip-shaped portion extending in the direction in which the smaller difference in expansion is generated between the differences Q_x and Q_y in expansion.

[0007] According to another preferred embodiment of the present invention, the thickness of the solder sealing frame is about 18 μm or more.

[0008] According to another preferred embodiment of the present invention, the coefficient of linear expansion in the x direction of the substrate is represented by A_x and the coefficient of linear expansion in the y direction of the substrate is represented by A_y. The coefficient of linear

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expansion in the x direction of the element is represented by B_x and the coefficient of linear expansion in the y direction of the element is represented by B_y. The length of the external side of the strip-shaped portion extending in the x direction of the first and second frame-shaped electrodes is represented by dl_x and the length of the external side of the strip-shaped portion extending in the y direction of the first and second frame-shaped electrodes is represented by dl_y. Then, the difference Q_x in expansion is represented by $Q_x = |A_x - B_x| \times dl_x$ (mm/°C), and the difference Q_y in expansion is represented by $Q_y = |A_y - B_y| \times dl_y$ (mm/°C), the larger difference in expansion between the differences Q_x and Q_y in expansion is about 2.2×10^{-5} (mm/°C) or less.

[0009]   According to another preferred embodiment of the present invention, when the ratio of flexural rigidity in the x direction between the element and the substrate is represented by R_x and the ratio of flexural rigidity in the y direction between the element and the substrate is represented by R_y, the larger ratio of flexural rigidity between the ratios R_x and R_y of flexural rigidity is about 1.2 or less.

[0010]   According to another preferred embodiment of the present invention, the element is a surface acoustic wave element.

[0011]   In the electronic component device according to another preferred embodiment of the present invention, the difference in expansion in the x direction between the element and the substrate is represented by Q_x and the difference in expansion in the y direction between the element and the

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substrate is represented by Q_y. Then, in each of the first frame-shaped electrode, the second frame-shaped electrode, and the solder sealing frame, the width of the strip-shaped portion extending in the direction in which the larger difference in expansion is generated between the differences Q_x and Q_y in expansion is smaller than the width of the strip-shaped portion extending in the direction in which the smaller difference in expansion is generated between the differences Q_x and Q_y in expansion. Therefore, the lifetime for thermal shock resistance can be improved, and thus the lifetime for thermal shock resistance required for general electronic component devices can be satisfied.

[0012]   In the electronic component device according to another preferred embodiment of the present invention, when the thickness of the solder sealing frame is about 18 μm or more, the lifetime for thermal shock resistance of the electronic component device can be further improved.

[0013]   In the electronic component device according to another preferred embodiment of the present invention, when the larger difference in expansion between the differences Q_x and Q_y in expansion is about 2.2×10^{-5} (mm/°C) or less, the lifetime for thermal shock resistance of the electronic component device can be further improved.

[0014]   In the electronic component device according to another preferred embodiment of the present invention, when the larger ratio of flexural rigidity between the ratios R_x and R_y of flexural rigidity is about 1.2 or less, the lifetime for thermal shock resistance of the electronic component

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device can be further improved.

[0015]   Other features, elements, steps, advantages and characteristics of the present invention will become more apparent from the following detailed description of preferred embodiments thereof with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]   Fig. 1 is a perspective view of an electronic component device according to a preferred embodiment of the present invention.

[0017]   Figs. 2A and 2B are an exploded perspective view of the electronic component device shown in Fig. 1.

[0018]   Fig. 3A is a plan view of a package substrate used in the electronic component device in Fig. 1 and Fig. 3B is a cross-sectional view taken along face A-A in Fig. 3A.

[0019]   Fig. 4A is a plan view of an element used in the electronic component device in Fig. 1 and Fig. 4B is a cross-sectional view taken along face B-B in Fig. 4A.

[0020]   Fig. 5A is a plan view of a solder sealing frame used in the electronic component device in Fig. 1 and Fig. 5B is a cross-sectional view taken along face C-C in Fig. 5A.

[0021]   Fig. 6 is a graph showing the relationship between the thickness of a solder sealing frame and the maximum amplitude of equivalent strain.

[0022]   Fig. 7 is a graph showing the relationship between the difference in expansion and the maximum amplitude of equivalent strain.

[0023]   Fig. 8 is a graph showing the relationship between

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the ratio of flexural rigidity and the maximum amplitude of equivalent strain.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024]　As described above, when a thermal shock is applied to the known electronic component device during a reliability test or during use, a strain or a fatigue breaking is generated in the sealed portion, resulting in a problem of sealing failure. For example, in order to check if the lifetime for thermal shock resistance ((high temperature side 85°C, low temperature side -55°C, 30 minutes each/1 cycle) × 500 cycles) required for general electronic component devices is satisfied, a thermal shock resistance test was performed (under the same condition as that in the lifetime for thermal shock resistance) using the known electronic component device. As a result, the sealed portion was broken because of a large difference in expansion, resulting in the sealing failure. Thus, the lifetime for thermal shock resistance could not be satisfied.

[0025]　To evaluate the lifetime for thermal shock resistance, for example, a shock is forcibly applied so that a strain is generated at a joined portion by a solder ball. In this case, the empirical equation of "the Coffin-Manson's law" derived for the resultant strain and the lifetime for thermal shock resistance is represented as follows: (maximum amplitude of equivalent strain) = $0.325 \times$ (lifetime (cycle))$^{-0.429}$ (refer to "Kairo jisso gakkaishi" (The Journal of Japan Institute for Interconnecting and Packaging Electronic

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Circuits), Vol. 12, No. 6 (1997), pp. 413-417, Fig. 7).

[0026]   The maximum amplitude of equivalent strain in this empirical equation means the dimension of amplitude caused by expansion and contraction of solder during the thermal shock resistance test of an electronic component device. Accordingly, it is known that reducing the maximum amplitude of equivalent strain can improve the lifetime for thermal shock resistance of the electronic component device.

[0027]   The above empirical equation is an equation relating to the fatigue life (lifetime for thermal shock resistance) for solder bumps. However, since the strain generated in solder is a parameter with generality, this equation can be applied to the lifetime for thermal shock resistance of a sealing frame or the like.

[0028]   The maximum amplitude of equivalent strain when a thermal shock was applied corresponding to the condition for the lifetime for thermal shock resistance required for general electronic component devices was calculated as about 2.2% by an FEM simulation. In other words, when the maximum amplitude of equivalent strain can be decreased to about 2.2% or less, the lifetime for thermal shock resistance required for general electronic component devices can be satisfied.

[0029]   Fig. 6 is a graph showing the relationship between the thickness of solder and the maximum amplitude of equivalent strain. As shown in Fig. 6, in order to control the maximum amplitude of equivalent strain to about 2.2% or less, the thickness of the solder should be about 18 μm or more.

[0030]   Fig. 7 is a graph showing the relationship between the difference in expansion and the maximum amplitude of equivalent strain. As shown in Fig. 7, in order to control the maximum amplitude of equivalent strain to about 2.2% or less, the difference in expansion should be about 2.2×10^{-5} mm/°C or less.

[0031]   Fig. 8 is a graph showing the relationship between the ratio of flexural rigidity and the maximum amplitude of equivalent strain. As shown in Fig. 8, in order to control the maximum amplitude of equivalent strain to about 2.2% or less, the ratio of flexural rigidity should be about 1.2 or less.

[0032]   That is, the present inventor has found that, in order to control the maximum amplitude of equivalent strain to about 2.2% or less, the thickness of the solder sealing frame should be about 18 μm or more, the larger difference in expansion between the differences Q_x and Q_y in expansion should be about 2.2×10^{-5} mm/°C or less, and the larger ratio of flexural rigidity between the ratios R_x and R_y of flexural rigidity should be about 1.2 or less.

[0033]   Furthermore, the present inventor has found the following: In each of the solder sealing frame, a first frame-shaped electrode, and a second frame-shaped electrode, when the width of a strip-shaped portion extending in the direction in which the larger difference in expansion is generated between the differences Q_x and Q_y in expansion is smaller than the width of a strip-shaped portion extending in the direction in which the smaller difference in expansion is

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generated between the differences Q_x and Q_y in expansion, the lifetime for thermal shock resistance of the electronic component device can be improved.

[0034]   Herein, each of the differences Q_x and Q_y in expansion means the differences between the coefficient of expansion of a substrate and the coefficient of expansion of an element. The difference Q_x in expansion in the x direction between the element and the substrate and the difference Q_y in expansion in the y direction between the element and the substrate are represented by equations of $Q_x = |A_x - B_x| \times dl_x$ (mm/°C) and $Q_y = |A_y - B_y| \times dl_y$ (mm/°C), respectively, wherein A_x represents the coefficient of linear expansion in the x direction of the substrate, A_y represents the coefficient of linear expansion in the y direction of the substrate, B_x represents the coefficient of linear expansion in the x direction of the element, B_y represents the coefficient of linear expansion in the y direction of the element, dl_x represents the length of the external side of the strip-shaped portion extending in the x direction of the first frame-shaped electrode and the second frame-shaped electrode, and dl_y represents the length of the external side of the strip-shaped portion extending in the y direction thereof.

[0035]   Herein, each of the ratios R_x and R_y of flexural rigidity means the ratio of flexural rigidity of a substrate and the flexural rigidity of an element. The ratio R_x of flexural rigidity in the x direction between the substrate and the element and the ratio R_y of flexural rigidity in the y direction between the substrate and the element are

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represented by equations of $R_x = (at^3 \cdot a_x \cdot Ea)/(bt^3 \cdot b_x \cdot Eb)$ and $R_y = (at^3 \cdot a_y \cdot Ea)/(bt^3 \cdot b_y \cdot Eb)$, respectively, wherein at represents the thickness of the substrate, a_x represents the length of a side extending in the x direction of the substrate, a_y represents the length of a side extending in the y direction of the substrate, Ea represents the Young's modulus of the substrate, bt represents the thickness of the element, b_x represents the length of a side extending in the x direction of the element, b_y represents the length of a side extending in the y direction of the element, and Eb represents the Young's modulus of the element.

[0036]   Specific, non-limiting preferred embodiments of the present invention will now be described with reference to the drawings, thereby clarifying the present invention.

[0037]   Fig. 1 is a perspective view of an electronic component device 20 according to a preferred embodiment of the present invention and Figs. 2A and 2B are an exploded perspective view of the electronic component device 20. In the electronic component device 20, an element 10 is mounted face-down on a package substrate 1.

[0038]   Fig. 3A is a plan view of a package substrate used in the electronic component device 20 and Fig. 3B is a cross-sectional view taken along a face including line A-A in Fig. 3A. The package substrate 1 is an airtight flat plate component made of a glass epoxy resin. The length a_x of a side extending in the x direction of the package substrate 1 is 2.0 mm, the length a_y of a side extending in the y direction is 2.0 mm, the thickness at is 0.25 mm, and the

Young's modulus Ea is 340,000 MPa. Both the coefficient A_x of linear expansion in the x direction of the package substrate 1 and the coefficient A_y of linear expansion in the y direction thereof are 7 ppm/°C.

[0039]   As shown in Fig. 3A, four rectangular plate-shaped bonding electrodes 2 and a frame-shaped electrode 3 serving as a second frame-shaped electrode (the frame-shaped electrode 14, described below, serves as the first frame-shaped electrode) are provided on the surface of the package substrate 1. The second frame-shaped electrode 3 is disposed so as to surround the bonding electrodes 2. The bonding electrodes 2 are connected to outer electrodes (not shown in the figure) for surface mounting, the outer electrodes being provided on the reverse face, via connecting portions in which an electrode material is embedded in through-holes (not shown in the figure). The frame-shaped electrode 3 is connected to an earth-side electrode (not shown in the figure).

[0040]   The frame-shaped electrode 3 has a rectangular frame shape and includes strip-shaped portions extending in the x direction and strip-shaped portions extending in the y direction. The length al_x of the external side of each strip-shaped portion extending in the x direction of the frame-shaped electrode 3 is 2.0 mm, the length al_y of the external side of each strip-shaped portion extending in the y direction is 2.0 mm, the width aw_x of the strip-shaped portion extending in the x direction is 0.18 mm, the width aw_y of the strip-shaped portion extending in the y direction is 0.20 mm, and the thickness aet is 0.01 mm.

[0041]　　　Fig. 5A is a plan view of a solder sealing frame 4 used in the electronic component device 20 and Fig. 5B is a cross-sectional view taken along a face including line C-C in Fig. 5A.　The solder sealing frame 4 has a rectangular frame shape and includes strip-shaped portions extending in the x direction and strip-shaped portions extending in the y direction.　The length cl_x of the external side of each strip-shaped portion extending in the x direction of the solder sealing frame 4 is 2.0 mm, the length cl_y of the external side of each strip-shaped portion extending in the y direction is 2.0 mm, the width cw_x of the strip-shaped portion extending in the x direction is 0.18 mm, the width cw_y of the strip-shaped portion extending in the y direction is 0.20 mm, and the thickness ct is 0.02 mm.　The solder sealing frame 4 is provided on the frame-shaped electrode 3 of the package substrate 1.　For example, eutectic solder paste is applied on the frame-shaped electrode 3 of the package substrate 1 by printing and the eutectic solder paste is subjected to reflow soldering.　Subsequently, cleaning is performed to remove the flux residue.　Thus, the solder sealing frame 4 is formed.　In addition to the printing, the solder sealing frame 4 may be formed by precoating such as the SJ process, plating, vacuum deposition, sputtering, or the like.　Although eutectic solder is used as the material of the solder sealing frame 4, the material is not limited to eutectic solder as long as the material is a metal that can be melted.

[0042]　　　Fig. 4A is a plan view of the element 10 used in the electronic component device 20 and Fig. 4B is a cross-

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sectional view taken along a face including line B-B in Fig. 4A. The element 10 is a rectangular plate-shaped surface acoustic wave element. The length b_x of a side extending in the x direction of the element 10 is 2.0 mm, the length b_y of a side extending in the y direction is 2.0 mm, the thickness bt is 0.35 mm, and the Young's modulus Eb is 230,000 MPa.

[0043] The element 10 includes a piezoelectric substrate 11 composed of quartz crystal, $LiTaO_3$, $LiNbO_3$, or the like and a functional part provided on the piezoelectric substrate 11. The functional part includes two pairs of IDTs 12 made of Al or the like and four input-output electrodes 13 made of Ti/Ni/Au. The IDTs 12 and the input-output electrodes 13 are connected to each other. The coefficient B_x of linear expansion of a side extending in the x direction of the element 10 is 16 ppm/°C and the coefficient B_y of linear expansion of a side extending in the y direction of the element 10 is 9 ppm/°C. The coefficient of linear expansion of the side extending in the x direction is different from the coefficient of linear expansion of the side extending in the y direction.

[0044] A frame-shaped electrode 14 serving as a first frame-shaped electrode is provided on the surface of the element 10 so as to surround the IDTs 12 and the input-output electrodes 13. The frame-shaped electrode 14 has a rectangular frame shape and includes strip-shaped portions extending in the x direction and strip-shaped portions extending in the y direction. The length bl_x of the external side of each strip-shaped portion extending in the x direction

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of the frame-shaped electrode 14 is 2.0 mm, the length bl_y of

the external side of each strip-shaped portion extending in

the y direction is 2.0 mm, the width bw_x of the strip-shaped

portion extending in the x direction is 0.18 mm, the width bw_y

of the strip-shaped portion extending in the y direction is

0.20 mm, and the thickness bet is 0.001 mm.

[0045]   As shown in Fig. 2A, bumps 15 are fixed on the

input-output electrodes 13. The bumps 15, which are Au bumps,

are formed by a wire bonding process. In place of the Au

bumps, metal bumps mainly made of Ag, Pd, and Cu solder bumps,

or the like may also be used. In place of the wire bonding

process, the bumps 15 may be formed by plating, a process of

setting solder balls, printing, or the like. The height of

the bumps 15 is preferably higher than the height of the

solder sealing frame 4 formed on the package substrate 1 and

is preferably about 40 μm to about 50 μm.

[0046]   In the package substrate 1 and the element 10, the

length of the sides extending in the x direction and the

length of the sides extending in the y direction are

substantially the same. Each of the bonding electrodes 2 of

the package substrate 1 and each of the input-output

electrodes 13 of the element 10 are disposed at corresponding

positions. The frame-shaped electrode 3 of the package

substrate 1 and the frame-shaped electrode 14 of the element

10 are also disposed at corresponding positions.

[0047]   The frame-shaped electrodes 3 and 14 are made of

Ni/Au. Nickel is used in order to prevent solder corrosion.

A metal other than Ni may be used as long as the metal can

prevent solder corrosion. In addition to Ni, examples of such a metal include Pt and Pd. Gold is used in order to ensure solderability. A metal other than Au may be used as long as the metal can ensure solderability. In addition to Au, examples of such a metal include Ag, Sn, Pt, and Cu.

[0048]   A method for bonding the package substrate 1 and the element 10 will now be described.

[0049]   As shown in Fig. 2A, an element 10 including IDTs 12, input-output electrodes 13, a frame-shaped electrode 14, and bumps 15 and, as shown in Fig. 2B, a package substrate 1 including bonding electrodes 2, a frame-shaped electrode 3, and a solder sealing frame 4 are prepared.

[0050]   The package substrate 1 is placed on a support such that the solder sealing frame 4 is disposed on the upper side, and the position of the package substrate 1 is fixed. Subsequently, the reverse face of the element 10 is applied with a vacuum with a bonding tool. The element 10 is positioned such that the frame-shaped electrode 3 of the package substrate 1 and the frame-shaped electrode 14 of the element 10 correspond below and above. Subsequently, a pressure is applied with ultrasonic waves using the bonding tool to bond the bumps 15 with the bonding electrodes 2 of the package substrate 1. Thereby, the bumps 15 and the bonding electrodes 2 of the package substrate 1 undergo diffusion bonding. At the same time, the melted solder sealing frame 4 is spread on the frame-shaped electrode 14 of the element 10 with wettability to hermetically seal the space between the package substrate 1 and the element 10.

[0051]   Finally, the resulting package substrate 1 and the element 10 are cooled to complete the bonding and sealing. Thus, a hermetically sealed electronic component device 20 can be produced.

[0052]   With respect to the electronic component device 20, the differences Q_x and Q_y in expansion generated between the package substrate 1 and the element 10 will be calculated.

[0053]   The differences Q_x and Q_y in expansion in the electronic component device 20 are calculated as follows: The difference Q_x in expansion is $|7$ ppm/$^\circ$C $- 16$ ppm/$^\circ$C$| \times 2.0$ mm $= 1.8 \times 10^{-6}$ mm/$^\circ$C, and the difference Q_y in expansion is $|7$ ppm/$^\circ$C $- 9$ ppm/$^\circ$C$| \times 2.0$ mm $= 4.0 \times 10^{-7}$ mm/$^\circ$C.   Thus, the difference Q_x in expansion is larger than the difference Q_y in expansion.

[0054]   In the electronic component device 20, the width cw_x of the strip-shaped portion extending in the x direction of the solder sealing frame 4 and widths aw_x and bw_x of the strip-shaped portions extending in the x direction of the frame-shaped electrodes 3 and 14, respectively, are 0.18 mm.   On the other hand, the width cw_y of the strip-shaped portion extending in the y direction of the solder sealing frame 4 and widths aw_y and bw_y of the strip-shaped portions extending in the y direction of the frame-shaped electrodes 3 and 14, respectively, are 0.20 mm.   In the electronic component device 20, the difference Q_x in expansion is larger than the difference Q_y in expansion.   That is, the widths aw_x, bw_x, and cw_x of the strip-shaped portions extending in the x direction of the frame-shaped electrodes 3 and 14 and the solder sealing

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frame 4 are smaller than the widths aw_y, bw_y, and cw_y of the strip-shaped portions extending in the y direction.

[0055] When the width of the strip-shaped portion extending in the direction in which the larger difference in expansion is generated between the differences Q_x and Q_y in expansion is smaller than the width of the strip-shaped portion extending in the direction in which the smaller difference in expansion is generated between the differences Q_x and Q_y in expansion, the electronic component device 20 can be miniaturized. On the other hand, in the solder sealing frame 4 and the frame-shaped electrodes 3 and 14, the maximum equivalent strains generated in the sides extending in the direction in which the larger difference in expansion is generated are barely changed. Accordingly, the electronic component device 20 can satisfy the lifetime for thermal shock resistance required for general electronic component devices.

[0056] Furthermore, in the electronic component device 20, the thickness ct of the solder sealing frame 4 is 0.02 mm (20 μm). By increasing the thickness of the solder sealing frame 4 to about 18 μm or more, when a thermal shock is applied during a reliability test or during use, a strain generated at the sealed portion between the package substrate 1 and the element 10 can be absorbed by the solder sealing frame 4. Accordingly, in the electronic component device 20, the maximum amplitude of equivalent strain generated in the solder sealing frame 4 can be reduced to about 2.2% or less.

[0057] In the electronic component device 20, the difference Q_x in expansion is larger than the difference Q_y in

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expansion. Accordingly, when the difference Q_x in expansion is about 2.2×10^{-5} mm/°C or less, the maximum amplitude of equivalent strain generated in the solder sealing frame 4 can be reduced to about 2.2% or less. Since the difference Q_x in expansion is about 1.8×10^{-6} mm/°C, which satisfies the condition of about 2.2×10^{-5} mm/°C or less, in the electronic component device 20, the maximum amplitude of equivalent strain generated in the solder sealing frame 4 can be reduced to about 2.2% or less.

[0058]   With respect to the electronic component device 20, the ratios R_x and R_y of flexural rigidity in the package substrate 1 and the element 10 will be calculated.

[0059]   The ratios R_x and R_y of flexural rigidity in the electronic component device 20 are calculated as follows: The ratio R_x of flexural rigidity is $(0.25^3$ mm $\times 2.0$ mm $\times 340,000$ MPa$)/(0.35^3$ mm $\times 2.0$ mm $\times 230,000$ MPa$)$ and the ratio R_y of flexural rigidity is $(0.25^3$ mm $\times 2.0$ mm $\times 340,000$ MPa$)/(0.35^3$ mm $\times 2.0$ mm $\times 230,000$ MPa$)$. The ratio R_x of flexural rigidity and the ratio R_y of flexural rigidity are the same value of about 0.54.

[0060]   The ratios R_x and R_y of flexural rigidity in the electronic component device 20 are about 0.54, which satisfies the condition of about 1.2 or less. Therefore, in the   · electronic component device 20, the maximum amplitude of equivalent strain generated in the solder sealing frame 4 can be reduced to about 2.2% or less.

[0061]   As described above, the maximum amplitude of equivalent strain generated in the solder sealing frame 4 can

be reduced to about 2.2% or less in the electronic component device 20. Consequently, even when a thermal shock is applied during a reliability test or during use, a strain or a fatigue breaking that is generated in the solder sealing frame 4 can be suppressed and thus sealing failure due to breaking of the sealed portion does not occur.

[0062]   Consequently, the electronic component device 20 has further improved lifetime for thermal shock resistance and excellent reliability.

[0063]   In the above preferred embodiment, the solder sealing frame 4 is provided on the package substrate 1. Alternatively, the solder sealing frame 4 may be provided on the element 10 or may be provided on each of the package substrate 1 and the element 10. When the solder sealing frames 4 are provided on both the package substrate 1 and the element 10, the solder sealing frames are bonded with each other to perform sealing.

[0064]   With respect to the solder sealing frame 4, the solder sealing frame 4 need not be entirely made of a base metal. It is sufficient that at least the surface thereof is made of a base metal.

[0065]   In place of metal bumps or solder bumps, base metal bumps such as Al bumps may be used as the bumps 15.

[0066]   A surface acoustic wave element is used as the element 10 in the above preferred embodiment. Alternatively, another element such as a high-frequency element may also be used as long as the coefficient of linear expansion in the x direction is different from the coefficient of linear

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expansion in the y direction.

[0067]   A glass epoxy resin is used for the package substrate 1 in the above preferred embodiment. Alternatively, another airtight substrate, for example, a glass substrate, a ceramic substrate made of alumina or the like, or a crystalline substrate may also be used.

[0068]   The solder sealing frame 4 may be connected to an earth-side circuit pattern (not shown in the figure) provided on the package substrate 1.

[0069]   While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many preferred embodiments other those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention which fall within the true spirit and scope of the invention.